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**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

### Office Action Summary

**Application No.**

10/540,112

**Applicant(s)**

KORATKAR ET AL.

**Examiner**

GURPREET KAUR

**Art Unit**

1795

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☐ Responsive to communication(s) filed on \_\_\_\_.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-30 is/are pending in the application.
- 4a) Of the above claim(s) 7 and 27-30 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-6 and 8-26 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on \_\_\_\_ is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO/SI/C)
- 4) ☐ Interview Summary (PTO-413)
- 5) ☐ Notice of Informal Patent Application
- 6) ☐ Other: \_\_\_\_
- Paper No(s)/Mail Date 6/20/2005 and 12/18/2006

**DETAILED ACTION**

***Status of the Claims***

1. Claims 1-30 are pending.
2. Claims 7 and 27-30 are withdrawn.
3. Claims 1-6 and 8-26 are being examined in this application.

***Election/Restrictions***

4. Restriction to one of the following inventions is required under 35 U.S.C. 121:
  - I. Claims 1-6 and 8-26, drawn to an ionization gas sensor, classified in class 204, subclass 426.
  - II. Claim 7, drawn to an ionization gas sensor with a gas chromatography device, classified in class 96, subclass 101.
  - III. Claims 27-30, drawn to method of making a microfabricated ionization chamber for ionization gas sensor, classified in class 427, subclass 497.

The inventions are distinct, each from the other because of the following reasons:

Inventions I and II are related as combination and subcombination. Inventions in this relationship are distinct if it can be shown that (1) the combination as claimed does not require the particulars of the subcombination as claimed for patentability, and (2) that the subcombination has utility by itself or in other combinations (MPEP § 806.05(c)). In the instant case, the combination as claimed does not require the

particulars of the subcombination as claimed because ionization gas sensor as claimed does not require a gas chromatography device to separate the gas mixture.

The subcombination has separate utility such as for separating the gas mixture containing the analyte gas.

The examiner has required restriction between combination and subcombination inventions. Where applicant elects a subcombination, and claims thereto are subsequently found allowable, any claim(s) depending from or otherwise requiring all the limitations of the allowable subcombination will be examined for patentability in accordance with 37 CFR 1.104. See MPEP § 821.04(a). Applicant is advised that if any claim presented in a continuation or divisional application is anticipated by, or includes all the limitations of, a claim that is allowable in the present application, such claim may be subject to provisional statutory and/or nonstatutory double patenting rejections over the claims of the instant application.

Inventions I and III are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make another and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case the product as claimed can be made by another and materially different process such as chemical etching or laser ablation.

Inventions II and III are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make another and materially different product or (2)

that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case the product as claimed can be made by another and materially different process such as chemical etching or laser ablation.

Restriction for examination purposes as indicated is proper because all these inventions listed in this action are independent or distinct for the reasons given above and there would be a serious search and examination burden if restriction were not required because one or more of the following reasons apply:

- (a) the inventions have acquired a separate status in the art in view of their different classification;
- (b) the inventions have acquired a separate status in the art due to their recognized divergent subject matter;
- (c) the inventions require a different field of search (for example, searching different classes/subclasses or electronic resources, or employing different search queries);
- (d) the prior art applicable to one invention would not likely be applicable to another invention;
- (e) the inventions are likely to raise different non-prior art issues under 35 U.S.C. 101 and/or 35 U.S.C. 112, first paragraph.

**Applicant is advised that the reply to this requirement to be complete must include (i) an election of an invention to be examined** even though the requirement

may be traversed (37 CFR 1.143) **and (ii) identification of the claims encompassing the elected invention.**

The election of an invention may be made with or without traverse. To reserve a right to petition, the election must be made with traverse. If the reply does not distinctly and specifically point out supposed errors in the restriction requirement, the election shall be treated as an election without traverse. Traversal must be presented at the time of election in order to be considered timely. Failure to timely traverse the requirement will result in the loss of right to petition under 37 CFR 1.144. If claims are added after the election, applicant must indicate which of these claims are readable on the elected invention.

If claims are added after the election, applicant must indicate which of these claims are readable upon the elected invention.

Should applicant traverse on the ground that the inventions are not patentably distinct, applicant should submit evidence or identify such evidence now of record showing the inventions to be obvious variants or clearly admit on the record that this is the case. In either instance, if the examiner finds one of the inventions unpatentable over the prior art, the evidence or admission may be used in a rejection under 35 U.S.C. 103(a) of the other invention.

During a telephone conversation with Leon Radomsky on 3/16/2010 a provisional election was made without traverse to prosecute the invention of I, claims 1-6 and 8-26. Affirmation of this election must be made by applicant in replying to this Office action.

Claims 7 and 27-30 are withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

The examiner has required restriction between product and process claims. Where applicant elects claims directed to the product, and the product claims are subsequently found allowable, withdrawn process claims that depend from or otherwise require all the limitations of the allowable product claim will be considered for rejoinder. All claims directed to a nonelected process invention must require all the limitations of an allowable product claim for that process invention to be rejoined.

In the event of rejoinder, the requirement for restriction between the product claims and the rejoined process claims will be withdrawn, and the rejoined process claims will be fully examined for patentability in accordance with 37 CFR 1.104. Thus, to be allowable, the rejoined claims must meet all criteria for patentability including the requirements of 35 U.S.C. 101, 102, 103 and 112. Until all claims to the elected product are found allowable, an otherwise proper restriction requirement between product claims and process claims may be maintained. Withdrawn process claims that are not commensurate in scope with an allowable product claim will not be rejoined. See MPEP § 821.04(b). Additionally, in order to retain the right to rejoinder in accordance with the

above policy, applicant is advised that the process claims should be amended during prosecution to require the limitations of the product claims. **Failure to do so may result in a loss of the right to rejoinder.** Further, note that the prohibition against double patenting rejections of 35 U.S.C. 121 does not apply where the restriction requirement is withdrawn by the examiner before the patent issues. See MPEP § 804.01.

### ***Drawings***

5. The drawings in figures 1A, 1C and 5 are objected to because they do not show every feature of the claims. Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended." If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

***Invocation of 35 USC § 112, sixth paragraph***

6. When claim language invokes 35 USC 112, sixth paragraph, a limit on is set on how broadly the PTO may construe means-plus-function language under the rubric of reasonable interpretation (See *Donaldson*, 16 F.3d at 1194, 29 USPQ2d at 1850). Additionally, the Federal Circuit has held that applicants before the USPTO have the opportunity and the obligation to define their inventions precisely during proceedings before the PTO (See *In re Morris*, 127 F.3d 1048, 1056–57, 44 USPQ2d 1023, 1029–30 (Fed. Cir. 1997). A claim limitation will be presumed to invoke 35 U.S.C. 112, sixth paragraph, if it meets the following 3-prong analysis:

- (A) the claim limitations must use the phrase “means for” or “step for;”
- (B) the “means for” or “step for” must be modified by functional language; and
- (C) the phrase “means for” or “step for” must not be modified by sufficient structure, material, or acts for achieving the specified function.

Instant claim 8 at line 2 recites in part the limitation “a means for determining.” This limitation utilize the terms “means for”; the “means for” is modified by functional language, specifically “determining”; and the phrase “means for” is not modified by sufficient structure, material, or acts for achieving the specified function. Therefore, claim 8 has invoked 35 USC 112, sixth paragraph. Regarding claim 8, Applicant's specification states the discharge sensor is used to determine species or concentration; therefore this limitation will be interpreted as any discharge sensor means known to person of ordinary skill in the art. Therefore, this limitation will be interpreted as

pertaining only to the corresponding structure, material or acts described in the specification, namely discharge sensor, or equivalents thereof.

### ***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.  
The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148

USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
  2. Ascertaining the differences between the prior art and the claims at issue.
  3. Resolving the level of ordinary skill in the pertinent art.
  4. Considering objective evidence present in the application indicating obviousness or nonobviousness.
7. Claims 1-3 and 8-11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhang et al. (Study of Gas Sensor with Carbon Nanotube Film on the Substrate of Porous Silicon, 2001, IEEE, 13-14) .

Regarding claims 1, 2 and 3, Zhang et al. teaches a gas sensor based on the gas discharge (see abstract) comprising:

- a first electrode (anode) (see figure 2);
- a second electrode (cathode) made up of carbon nanotube (CNT) array film (see figure 2);

voltage is applied to the anode and cathode to generate electric field on the surface of the tips of CNT to breakdown the gas (see page 14, paragraph 1);

Zhang teaches the voltage is applied between the anode and the cathode (CNT array film), thus it would be obvious that cathode formed of the CNT array film has enough density to behave as a cathode.

The limitation where sensor is adapted to determine at least one of gas specie and an analyte gas concentration for pure analyte gases and for analyte gases located in an analyte gas mixture is an intended use of the device as claimed. The cited prior art teaches all of the positively recited structure of the claimed apparatus. The Courts have held that a statement of intended use in an apparatus claim fails to distinguish over a prior art apparatus. See *In re Sinex*, 309 F.2d 488, 492, 135 USPQ 302, 305 (CCPA 1962). The Courts have held that the manner of operating an apparatus does not differentiate an apparatus claim from the prior art, if the prior art apparatus teaches all of the structural limitations of the claim. See *Ex Parte Masham*, 2 USPQ2d 1647 (BPAI 1987). The Courts have held that apparatus claims must be structurally distinguishable from the prior art in terms of structure, not function. See *In re Danley*, 120 USPQ 528, 531 (CCPA 1959); and *Hewlett-Packard Co. V. Bausch and Lomb, Inc.*, 15 USPQ2d 1525, 1528 (Fed. Cir. 1990) (see MPEP §§ 2114 and 2173.05(g)).

Therefore it would be obvious to person of ordinary skill in the art at the time of the invention that Zhang teaches all recited structural elements of the gas sensor as claimed and thus Zhang gas sensor can determine at least an analyte gas species.

8. Regarding claim 8, Zhang teaches a gas sensor based on the gas discharge which is capable of determining gas variety and concentration of the gases (see abstract).

9. Regarding claims 9 and 10, Zhang teaches voltage and ampere measurements are taken for the 5 gases to determine the gas variety and gas concentration (see abstract and page 14, paragraph 4). Thus it would be obvious to one of ordinary skill in the art that Zhang sensor comprises of voltmeter and ammeter to measure voltage and current respectively.

10. Regarding claim 11, Zhang teaches the electric field is near the tip surface of the nanotubes which induces breakdown of the gas to produce discharge current (see abstract and page 14, paragraphs 1-3) and breakdown of the gas inherently produces plasma discharge. Thus it is obvious to one of ordinary skill in the art that discharge current occurs in the gas-filled space between two conductive electrodes and thus the gap between the first and the second electrodes is bridged.

11. Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over Zhang et al. (Study of Gas Sensor with Carbon Nanotube Film on the Substrate of Porous Silicon, 2001, IEEE, 13-14) in view of Kong et al. (Nanotube Molecular Wires as Chemical Sensors, Science, 2000, 287, 622-625).

Regarding claim 4, Zhang et al. teaches a gas sensor based on the gas discharge (see abstract) comprising:

a first electrode (anode) (see figure 2);

a second electrode (cathode) made up of carbon nanotube (CNT) array film (see figure 2);

voltage is applied to the anode and cathode to generate electric filed on the surface of the tips of CNT to breakdown the gas (see page 14, paragraph 1);

Zhang does not indicate that the nanotube film is single walled carbon film.

However, Kong et al. teaches that a single-walled carbon nanotubes sensors to detect toxic gas molecules (see page 622, col. 1, paragraph 1) and single-walled carbon nanotubes can be operated at room temperature with high sensitivity (see page 625, col. 1, paragraph 1).

Therefore it would be obvious to person of ordinary skill in the art at the time of the invention to incorporate single walled carbon nanotubes of Kong to make the carbon nanotube array film of Zhang because single-walled carbon nanotubes can be operated at room temperature with high sensitivity (see page 625, col. 1, paragraph 1).

12. Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Zhang et al. (Study of Gas Sensor with Carbon Nanotube Film on the Substrate of Porous Silicon, 2001, IEEE, 13-14) in view of Ghee et al. (Nanotube Molecular Wires as Chemical Sensors, Science, 2000, 287, 622-625).

Regarding claim 5, Zhang et al. teaches a gas sensor based on the gas discharge (see abstract) comprising:

a first electrode (anode) (see figure 2);

a second electrode (cathode) made up of carbon nanotube (CNT) array film (see figure 2);

voltage is applied to the anode and cathode to generate electric field on the surface of the tips of CNT to breakdown the gas (see page 14, paragraph 1);

Zhang does not teach that a microfabricated ionization chamber containing the electrodes.

However, Ghee et al. teaches a carbon nanotube based sensor which is placed in a sealed plexiglass chamber to monitor via a loop the concentration of the gases (see abstract and figure 2).

Therefore it would be obvious to person of ordinary skill in the art at the time of the invention to incorporate the Zhang sensor assembly in a sealed plexiglass chamber as taught by Ghee because sensor assembly in a sealed environment would provide better sensitivity and good detection.

13. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Zhang et al. (Study of Gas Sensor with Carbon Nanotube Film on the Substrate of Porous Silicon, 2001, IEEE, 13-14) in view of Cole et al. (U.S. Pat. No. 6,919,730).

Regarding claim 6, Zhang et al. teaches a gas sensor based on the gas discharge (see abstract) comprising:

a first electrode (anode) (see figure 2);

a second electrode (cathode) made up of carbon nanotube (CNT) array film (see figure 2);

voltage is applied to the anode and cathode to generate electric field on the surface of the tips of CNT to breakdown the gas (see page 14, paragraph 1);

Zhang does not teach that voltage source is battery powered.

However, Cole et al. teaches carbon nanotube sensor is powered by battery, thus sensor does not need to be operated until needed (see col. 5, ll. 15-19).

Therefore it would be obvious to person of ordinary skill in the art at the time of the invention to power the sensor of Zhang by battery as taught by Cole because battery powered sensor can be operated when needed (see col. 5, ll. 15-19) and also making them portable to carry around.

14. Claims 12 and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhang et al. (Study of Gas Sensor with Carbon Nanotube Film on the Substrate of Porous Silicon, 2001, IEEE, 13-14) in view of Zhang Z. et al. (Substrate-site selective growth of aligned carbon nanotube).

Regarding claims 12 and 13, Zhang teaches a first electrode (anode) made up of iron slice (sheet) and a second electrode (cathode) made up of carbon nanotube (CNT) array film (see figure 2). Zhang teaches high electric current field is obtained around the tip of CNT to breakdown the gas (see page 13, Introduction section). Thus it is obvious

the gas detection volume i.e. space between the two electrode is a gas detection volume.

Zhang does not specifically indicate that the carbon nanotubes (multi-walled carbon nanotubes) are aligned and extending toward the first electrode.

However, Zhang. Z teaches substrate-site selective growth of multiwalled carbon nanotubes vertically (see page 3765, col. 1, ll. 1-5).

Thus with combined teachings of Zhang and Zhang. Z the vertically aligned multiwalled carbon nanotubes replaced with carbon nanotube array film of Zhang will extend toward the first electrode. It would be obvious to one of ordinary skill in the art to modify the nanotube array of Zhang with the vertically aligned multi-walled carbon nanotube of Zhang Z. because such nanotubes are well aligned and organized on planar structure (see abstract).

The limitation reciting the carbon nanotube film is anode is just an intended use of the electrode. The cited prior art teaches all of the positively recited structure of the claimed apparatus. The Courts have held that a statement of intended use in an apparatus claim fails to distinguish over a prior art apparatus. See *In re Sinex*, 309 F.2d 488, 492, 135 USPQ 302, 305 (CCPA 1962). The Courts have held that the manner of operating an apparatus does not differentiate an apparatus claim from the prior art, if the prior art apparatus teaches all of the structural limitations of the claim. See *Ex Parte Masham*, 2 USPQ2d 1647 (BPAI 1987). The Courts have held that apparatus claims must be structurally distinguishable from the prior art in terms of structure, not function. See *In re Danley*, 120 USPQ 528, 531 (CCPA 1959); and *Hewlett-Packard Co. V.*

*Bausch and Lomb, Inc.*, 15 USPQ2d 1525, 1528 (Fed. Cir. 1990) (see MPEP §§ 2114 and 2173.05(g)).

15. Claim 14 is rejected under 35 U.S.C. 103(a) as being unpatentable over Zhang et al. (Study of Gas Sensor with Carbon Nanotube Film on the Substrate of Porous Silicon, 2001, IEEE, 13-14) in view of Ghee et al. (Nanotube Molecular Wires as Chemical Sensors, Science, 2000, 287, 622-625) and Bhagat et al. (U.S. Pat. No. 4,668,374).

Regarding claim 14, Zhang et al. teaches a gas sensor based on the gas discharge (see abstract) comprising: a first electrode (anode) (see figure 2) and a second electrode (cathode) made up of carbon nanotube (CNT) array film (on inside of a lower substrate (1) (see figure 2).

Ghee et al. teaches a carbon nanotube based sensor wherein the conductor layer 1 and 2 are supported on the inner surface of the upper substrate (see figure 1) and the sensor is placed in a sealed plexiglass chamber to monitor via a loop the concentration of the gases (see abstract and figure 2).

Both Zhang and Ghee does not teach template material located over the inner surface of lower substrate.

However, Zhang Z. teaches selective growth of nanotubes on pattern substrate i.e. iron coated SiO<sub>2</sub> substrate (see page 3765, col. 1, paragraph 1 and col. 2, paragraph 1).

Thus upon combined teachings of Zhang Z. and Zhang the second electrode will located on the template material (pattern substrate).

Therefore it would be obvious to person of ordinary skill in the art at the time of the invention to modify the lower substrate of Zhang with the pattern substrate of Zhang Z. because the pattern substrate allow nanotubes to grown at site specific locations and growth with aligned nanotubes (see page 3765, col. 2, paragraph 1).

Zhang does not specifically indicate a gas detection volume but however does teach discharge of the gas take place around the carbon nanotube tips array (see page 14, paragraph 3) which is located in the volume (space) between two electrodes (see figure 2), thus it is obvious to one of ordinary skill in the art that the space is a gas detection volume.

Zhang, Ghee and Zhang Z. do not teach the gas detection volume is 10 to 50 nanoliter.

However, Bhagat et al. teaches a gas sensor wherein the chamber possesses volume of 20 nanoliters (see claim 1 and 19).

Furthermore, "[W]here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation." See *In re Aller*, 220 F.2d 454, 456, 105 USPQ 233, 235 (CCPA 1955). The discovery of an optimum value of a known result effective variable, without producing any new or unexpected results, is within the ambit of a person of ordinary skill in the art. See *In re Boesch*, 205 USPQ 215 (CCPA 1980) (see MPEP § 2144.05, II.).

Therefore it would be obvious to person of ordinary skill in the art at the time of the invention to modify the chamber volume to a desired volume to test the gas samples.

Zhang teaches a gas sensor wherein the voltage is applied to the electrodes. Thus is it obvious to person of ordinary skill in the art that the contact pads for each electrode are also present and are connected to voltage source via a lead. Moreover, it is known in the art to drill vias in PCB substrate to attach electrodes other components to other surfaces of the substrate.

16. Claim 15 is rejected under 35 U.S.C. 103(a) as being unpatentable over Zhang et al. (Study of Gas Sensor with Carbon Nanotube Film on the Substrate of Porous Silicon, 2001, IEEE, 13-14) and in view of Coll et al. (U.S. Pub. No. 2003/0042226) .

Regarding claim 15, Zhang et al. does not explicitly indicate spacing between the adjacent nanotubes is 40 to 100 nm.

However, Coll et al. teaches method of forming nanotubes wherein the spacing between the nanotubes is about 20 nm to 2000 nm.

Furthermore, "[W]here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation." See *In re Aller*, 220 F.2d 454, 456, 105 USPQ 233, 235 (CCPA 1955). The discovery of an optimum value of a known result effective variable, without producing any new or unexpected results, is within the ambit of a person of ordinary

skill in the art. See *In re Boesch*, 205 USPQ 215 (CCPA 1980) (see MPEP § 2144.05, II.).

Therefore it would be obvious to person of ordinary skill in the art at the time of the invention to modify the spacing between the nanotubes to a desired space required between the nanotubes.

17. Claims 16, 17, 22, 24, 25 and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhang et al. (Study of Gas Sensor with Carbon Nanotube Film on the Substrate of Porous Silicon, 2001, IEEE, 13-14) .

Regarding claims 16, 17, 24 and 25, Zhang et al. teaches a gas sensor based on the gas discharge to detect variety of gases and concentration (see abstract) comprising:

a first electrode (anode) (see figure 2) and a second electrode (cathode) made up of carbon nanotube (CNT) array film (see figure 2). Zhang does not specifically indicate a gas detection volume but however does teach discharge of the gas take place around the carbon nanotube tips array (see page 14, paragraph 3) which are located in the volume between two electrodes (see figure 2), thus it is obvious to one of ordinary skill in the art that the analyte gas is provided into gas detection volume;

voltage is applied to the anode and cathode to generate electric field on the surface of the tips of CNT to breakdown the gas to determine analyte gas concentration from the measured current and species from the measured voltage (see page 14, paragraphs 1 and 3);

Zhang teaches the voltage is applied between the anode and the cathode (CNT array film), thus it would be obvious that cathode formed of the CNT array film has enough density to behave as a cathode.

18. Regarding claim 22, Zhang teaches the breakdown voltage is less than 220V and breakdown voltage of air was 128 V (see page 14, paragraph 2 and 4).

19. Regarding claim 26, Zhang teaches the electric field is near the tip surface of the nanotubes which induces breakdown of the gas to produce discharge current (see abstract and page 14, paragraphs 1-3) and breakdown of the gas inherently produces plasma discharge. Thus it is obvious to one of ordinary skill in the art that discharge current occurs in the gas-filled space between two conductive electrodes and thus the gap between the first and the second electrodes is bridged.

20. Claims 18 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhang et al. (Study of Gas Sensor with Carbon Nanotube Film on the Substrate of Porous Silicon, 2001, IEEE, 13-14) in view of Zhang Z. et al. (Substrate-site selective growth of aligned carbon nanotube) as evidenced by Redlich et al. (B-C-N nanotube and boron doping of carbon nanotubes, Chemical Phys Letters, 1996, 465-470).

Regarding claims 18 and 19, Zhang teaches a first electrode (anode) made up of iron slice (sheet) and a second electrode (cathode) made up of carbon nanotube (CNT) array film (see figure 2). Zhang teaches high electric current field is obtained around the

tip of CNT to breakdown the gas (see page 13, Introduction section). Thus it is obvious the gas detection volume i.e. space between the two electrode is a gas detection volume.

Zhang teaches CNT is a cathode, however one of ordinary skill in the art can use either of the electrodes as anode or cathode to measure current across the electrodes as further evidenced by Redlich that carbon nanotubes as anode in a dc electric arc.

Zhang does not specifically indicate that the carbon nanotubes (multi-walled carbon nanotubes) are aligned and extending toward the first electrode.

However, Zhang. Z teaches substrate-site selective growth of multiwalled carbon nanotubes vertically (see page 3765, col. 1, ll. 1-5).

Thus with combined teachings of Zhang and Zhang. Z the vertically aligned multiwalled carbon nanotubes replaced with carbon nanotube array film of Zhang will extend toward the first electrode. It would be obvious to one of ordinary skill in the art to modify the nanotube array of Zhang with the vertically aligned multi-walled carbon nanotube of Zhang Z. because such nanotubes are well aligned and organized on planar structure (see abstract).

21. Claim 20 is rejected under 35 U.S.C. 103(a) as being unpatentable over Zhang et al. (Study of Gas Sensor with Carbon Nanotube Film on the Substrate of Porous Silicon, 2001, IEEE, 13-14) in view of Ghee et al. (Nanotube Molecular Wires as Chemical Sensors, Science, 2000, 287, 622-625) and Bhagat et al. (U.S. Pat. No. 4,668,374).

Regarding claim 20, Zhang teaches the breakdown of the gas occurs at the CNT tips and discharge current and voltage is measured (see page 14, paragraph 1 and 2) thus analyte gas is provided into the detection volume.

Zhang does not specifically indicate the gas is provided in the impermeable ionization chamber.

However, Ghee et al. teaches a carbon nanotube based sensor which is placed in a sealed plexiglass chamber to monitor via a loop the concentration of the gases and gas is provided through an inlet (see abstract and figure 2).

Therefore it would be obvious to person of ordinary skill in the art at the time of the invention to incorporate the Zhang sensor assembly in a sealed plexiglass chamber as taught by Ghee because sensor assembly in a sealed environment would provide better sensitivity and good detection.

Neither Zhang nor Ghee teaches gas detection volume of the chamber is 10 to 50 nanoliter.

However, Bhagat et al. teaches a gas sensor wherein the chamber possesses volume of 20 nanoliters (see claim 1 and 19).

Furthermore, "[W]here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation." See *In re Aller*, 220 F.2d 454, 456, 105 USPQ 233, 235 (CCPA 1955). The discovery of an optimum value of a known result effective variable, without producing any new or unexpected results, is within the ambit of a person of ordinary skill in the art. See *In re Boesch*, 205 USPQ 215 (CCPA 1980) (see MPEP § 2144.05, II.).

Therefore it would be obvious to person of ordinary skill in the art at the time of the invention to modify the chamber volume to a desired volume to test the gas samples.

22. Claim 21 is rejected under 35 U.S.C. 103(a) as being unpatentable over Zhang et al. (Study of Gas Sensor with Carbon Nanotube Film on the Substrate of Porous Silicon, 2001, IEEE, 13-14) in view of Cole et al. (U.S. Pat. No. 6,919,730).

Regarding claim 21, Zhang et al. teaches a gas sensor based on the gas discharge (see abstract) comprising:

- a first electrode (anode) (see figure 2);

- a second electrode (cathode) made up of carbon nanotube (CNT) array film (see figure 2);

voltage is applied to the anode and cathode to generate electric field on the surface of the tips of CNT to breakdown the gas (see page 14, paragraph 1);

Zhang does not teach that voltage source is battery powered.

However, Cole et al. teaches carbon nanotube sensor is powered by battery, thus sensor does not need to be operated until needed (see col. 5, ll. 15-19).

Therefore it would be obvious to person of ordinary skill in the art at the time of the invention to power the sensor of Zhang by battery as taught by Cole because battery powered sensor can operated when needed (see col. 5, ll. 15-19) and also making them portable to carry around.

23. Claim 23 is rejected under 35 U.S.C. 103(a) as being unpatentable over Zhang et al. (Study of Gas Sensor with Carbon Nanotube Film on the Substrate of Porous Silicon, 2001, IEEE, 13-14) in view of Zromb et al. (U.S. Pat. No. 4,888,295).

Regarding claim 23, Zhang does not teach separating the gas mixture into constituent gases.

However, Zromb et al. teaches in figure 12 a gas chromatograph is coupled to electrochemical sensor to detect gases in a mixture. The gas chromatograph is inherently capable of separating mixture of components of sample prior to sending to electrochemical sensor to identify and calculate the concentration of the gaseous components (see col. 2, ll. 54-57, col. 3, ll. 1-15, col. 4, ll. 49-53 and Figure 12).

Therefore it would be obvious to person of ordinary skill in the art at the time of the invention to modify the method of Zhang by adding the step of separating the gas mixture components by gas chromatograph of Zromb because the separated components can be detected down to levels of parts per billion or less in complex mixture (see col. 2, ll. 1-3).

### ***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to GURPREET KAUR whose telephone number is (571)270-7895. The examiner can normally be reached on Monday-Friday (Alternate Friday Off), 8:00-5pm EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nam Nguyen can be reached on (571)272-1342. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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